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Research Output of ICAR-Indian Institute of Horticultural Research: A Scientometric Study

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Abstract

This paper deals with the analysis of research output of ICAR- Indian Institute of Horticulture, Bangalore (ICAR-IIHR) during 1989 to 2018 appeared in web of science database. It attempts to analyze the growth and development of research activity of ICAR-IIHR as reflected in publications output in web of science database. Data for a study is total of 1095 have been downloaded and analyzed according to objectives. The study reveals that the growth of literature follows the exponential growth pattern, journal articles are the most published form of literature (90.13%), Indian Journal of Agricultural Sciences followed by Current Science are top journals, United States and Horticultural experiment Station are top collaborating country and institutions. The highly productive subject areas are Agriculture and Plant Sciences .Collaborating authorship pattern analysis shows that degree of collaboration (90%) significantly high. Overall, the paper presents an informed account of ICAR-IIHR's research performance.

Keywords: ICAR-IIHR , Scientometrics, Authorship pattern Agriculture , Horticulture and Research Output

1. Introduction

The ICAR-Indian Institute of Horticultural Research, an ISO 9001:2008 certified organization is a premier Institute conducting basic, strategic, anticipatory and applied research on all aspects of fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms. The Institute was the first horticultural research Institute in the country established by the Indian Council of Agricultural Research (ICAR), New Delhi on September 05, 1967 which was initially established at the ICAR headquarters, New Delhi and subsequently shifted to Bengaluru in Karnataka on February 01, 1968. The Vision of the Institute has been defined as "Technology-led, demand-driven and need-based sustainable horticulture for attaining food and nutritional security, better livelihood options and ultimately, economic development".

2. Review of Literature

Swain, C., Swain, D. K., and Rautaray, B. (2013) have analyzed 275 scholarly articles of Library Review from the year 2007 to 2011; single authored articles occupy the prominent position indicating the supremacy of solo research. The degree of collaboration in the publications of this journal is found to be 0.36. It is evident that LR has accommodated over 22 citations per article and regard to country productivity, the UK leads the table, followed by the USA and Nigeria. The findings of this study will serve as a model for future single journal bibliometric studies of journals of similar stature.

Serenko, A. (2013) has described the overall volume of scientometrics Knowledge Management works has been growing, reaching up to ten publications per year by 2012, but their key findings are somewhat inconsistent. The top six most productive countries are the USA, the UK, Canada, Germany, Australia, and Spain. Knowledge management exhibits attributes of a healthy academic domain with no apparent anomalies and is progressing towards academic maturity. This is the first documented attempt to conduct a meta-analysis of scientometrics research of the Knowledge management.

Bharadwaj, R. K., and Ram, S. (2013) have focused the Osteoporosis research output, one of the silent disease causes of fractures and disability in the aged. The data were obtained from Scopus from the year 1973 to 2012. USA is the most productive country with global share 27.21% publications. Indian researchers have contributed 1.02% with 921papers. AIIMS, Delhi is the most productive institution in India. India's highest research collaboration has been with USA within the period. Osteoporosis International (21 papers; IF 4.58) is the most productive journal in Indian research and N. Chattopadhyay (25 papers, 12.25%, and h-index 12) form Central Drug Institute; Lucknow is the most productive author in Osteoporosis research.

Dutt, B., and Nikam, K. (2013) have examined the Solar cell research for the period of 20 years from the Web of Science (WOS) database. The 90% contributions from top 22 Indian Institutions like IITs, IISc, CSIR, DAE and seven State Universities. CSIR-IICT, IISc, Shivaji University (AU) and Alagappa University (AU) had the highest citation rate and citation per paper. The International research trends as more than 90% originating from the USA, UK and other advanced countries in Europe. Among the all types of Solar cells Organic and Polymer solar cell, dye-sensitized solar cell, photoelectrochemical solar cell and quantum dot solar cell were the recent focus of research of Indian scientists.

According to Thanuskodi (2011), identified bibliometric analysis of articles and references provided at the end of each article contributed in *Indian Journal of Chemistry* from 2005-2009. The analysis cover mainly the number of articles, authorship pattern, forms of document cited, etc. All the studies point towards the merit and weakness of the journal which will be helpful for its further development. This study showed that most of the contributions are India. The authorship pattern of the articles published during the period of study. Maximum number of articles were contributed by two authors. This study also showed that majority of the contributors preferred journals as the source of information which occupied the top position. All the studies point towards the merits and weakness of the journal which will be helpful for its further development.

Gupta, B. M., and Kaur, H. (2013) have analyzed the global research output in glaucoma research during 2002 to 2011, 33098 papers were published. USA tops the list with a global publication share of 27.25% followed by China (8.60%), UK (8.09%) and India ranks 6th with 3.26% and an annual average publications growth rate 6.94%. University of Melbourne, Centre for Eye research registered the higher publications with 298 papers and Harvard Business School, Boston, 293 papers. Only seven Indian institutes have registered higher impact than the group average. In glaucoma, research witnessed an annual average growth rate of 6.94%.

Mukherjee, B. (2013) has presented the research performance and contributions of Prof. Lalji Singh an eminent Indian Scientist in the field of genome analysis, DNA finger printing, etc., 222 articles were indexed in the WoS and Scopus database during 1968 to 2011. The highest number of articles appeared in 2006 (27). He wrote 05 articles under single-authorship, 13 in two-authorship, and 20 in four-authorship and so on, and he is serving as a leader of his research term and K. Thangaraj is the fellow scientist with whom he wrote most. Prof. Singh has cited 3978 (up to July 2012) times with an average of 17.83 citations per paper. The percent H-index of Prof. Singh has reached 30, which is rare among Indian Scientists.

Konur, O. (2012) has evaluated the global research performed by the higher education institutions on the education for the period from 1980 to 2011. The total 179,832 references with 69.6% were articles followed by book reviews 16.7%, editorial materials 5.5%, proceedings papers 2.6%, note 2.3%, and reviews 2.1%. The other materials constituted 3.9% of the sample. Countries publishing the most are USA with 61.7% followed by England (9.6%), Canada (5.4%), Australia (4.9%), and Netherlands (2.2%). In addition, most prolific authors, as the universities, were from the most publishing countries such as the US.

Sinha, B., and Joshi, k. (2012) have analyzed the status of solar photovoltaic (PV) research in India during the year 2000 to 2009. India solar PV comprises of 1375 journal papers, 381 conference papers, 52 reviews and 6 other type documents. India has increased almost steadily at the rate of 16% per year (global AAGR 19%) with slight dip in 2001and somewhat larger decline in 2005. This study concludes with comprehensive mapping of solar PV R&D capability of India should be taken out on a priority bases in order to make effective R&D strategies to make advantage of supportive policy initiatives like the National Mission 2010.

3. Objectives of the Study

The main objectives of this study is to analysis the research output of the Indian Institute of Horticultural Research as reflected in the publication output during 1989-2018 the study focuses on the following aspects.

- To analyze the growth pattern of research publication output of ICAR-IIHR during 1989-2018 and find out the Relative Growth Rate and Doubling Time of that publications.
- To find out the most productive journal preferred by the faculties of ICAR-IIHR and evaluate the journals by using scientometric Indicators such as Impact Factor (IF) and H-Type Index.
- To identify the most prolific faculties in ICAR-IIHR by using different quality Indicators such as H-index and g-index
- To examine authorship patterns and degree of collaboration of faculties ICAR-IIHR to identify the most collaborating institutions and countries
- High Productive Subject areas in the research output of ICAR –IIHR

4. Data Collection and Research Methodology

Collection of the data is the first and important step of any scientometrics study. The Data for this study have been retrieved from web of science (wos) bibliographical database. The data collected for this purpose covers publications of the period 1989-2018. 30 years is an enough period to be a sign of the research status of any institution. A query of the following form was made to collect data using WOS search string ORANGIZATION ENHANCED search:= "ICAR-Indian Institute of Horticultural Research". Bibliographical data are distributed in Hitscite Software and MS Excel worksheet using for statistical analysis.

5. Analysis and Discussion

5.1 Research Output and Growth Trend

There are total 1095 publications in WOS during the period 1989-2018 for ICAR-IIHR Fig. 1 shows the 30 years growth of total papers (TP). An overall increasing trend was observed in the last 15 years. The growth ICAR-IIHR research productivity is also illustrated in figure 1 to reveal best fit model. A simple linear and exponential growth model was performed on 30 years of data. The figure 1 indicates the research publication output grows exponentially.

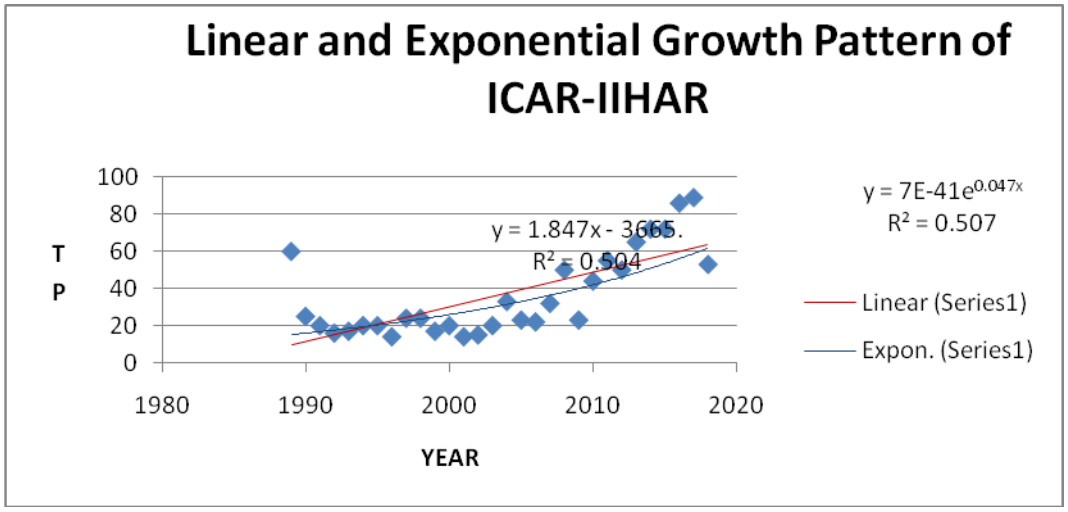

Fig.1 Year wise Research output

5.2. Relative Growth Rate (RGR) and Doubling Time (DT) of Publication

A study of data in table 1 & Figure 2 indicates that the relative Growth rate and Doubling time for publications of ICAR-IIHR. It is clear that relative Growth rate of total research output is decreased gradually. The Growth rate is 0.35 in 1990 and which decreased up to 0.05 in 2018. The mean relative Growth rate for the periods of 1989 to 20189 is 0.1. This study period resulted that the mean doubling time for total output 8.12.

Year	Papers	Percentage	Cumulative of Papers	W1	W2	R(a) (1-2)	Mean R (a) (1-2)	Doubling Time Dt (a)	Mean Dt(a) (1-2)
1989	60	5.48	60		4.09				
1990	25	2.28	85	4.09	4.44	0.35		1.99	
1991	20	1.83	105	4.44	4.65	0.21		3.28	
1992	16	1.46	121	4.65	4.80	0.14		4.89	
1993	17	1.55	138	4.80	4.93	0.13		5.27	
1994	20	1.83	158	4.93	5.06	0.14		5.12	
1995	20	1.83	178	5.06	5.18	0.12		5.81	
1996	14	1.28	192	5.18	5.26	0.08		9.15	
1997	24	2.19	216	5.26	5.38	0.12		5.88	
1998	24	2.19	240	5.38	5.48	0.11		6.58	
1999	17	1.55	257	5.48	5.55	0.07		10.13	
2000	20	1.83	277	5.55	5.62	0.07		9.25	
2001	14	1.28	291	5.62	5.67	0.05		14.06	
2002	15	1.37	306	5.67	5.72	0.05		13.79	
2003	20	1.83	326	5.72	5.79	0.06	**0.1**	10.95	**8.12**
2004	33	3.01	359	5.79	5.88	0.10		7.19	
2005	23	2.10	382	5.88	5.95	0.06		11.16	
2006	22	2.01	404	5.95	6.00	0.06		12.38	
2007	32	2.92	436	6.00	6.08	0.08		9.09	
2008	50	4.57	486	6.08	6.19	0.11		6.38	
2009	23	2.10	509	6.19	6.23	0.05		14.99	
2010	44	4.02	553	6.23	6.32	0.08		8.36	
2011	55	5.02	608	6.32	6.41	0.09		7.31	
2012	50	4.57	658	6.41	6.49	0.08		8.77	
2013	65	5.94	723	6.49	6.58	0.09		7.36	
2014	72	6.58	795	6.58	6.68	0.09		7.30	
2015	72	6.58	867	6.68	6.77	0.09		7.99	
2016	86	7.85	953	6.77	6.86	0.09		7.33	
2017	89	8.13	1042	6.86	6.95	0.09		7.76	
2018	53	4.84	1095	6.95	7.00	0.05		13.97	
	1095								

Tab:1 Relative Growth Rate (RGR) and Doubling Time (DT) of Publication

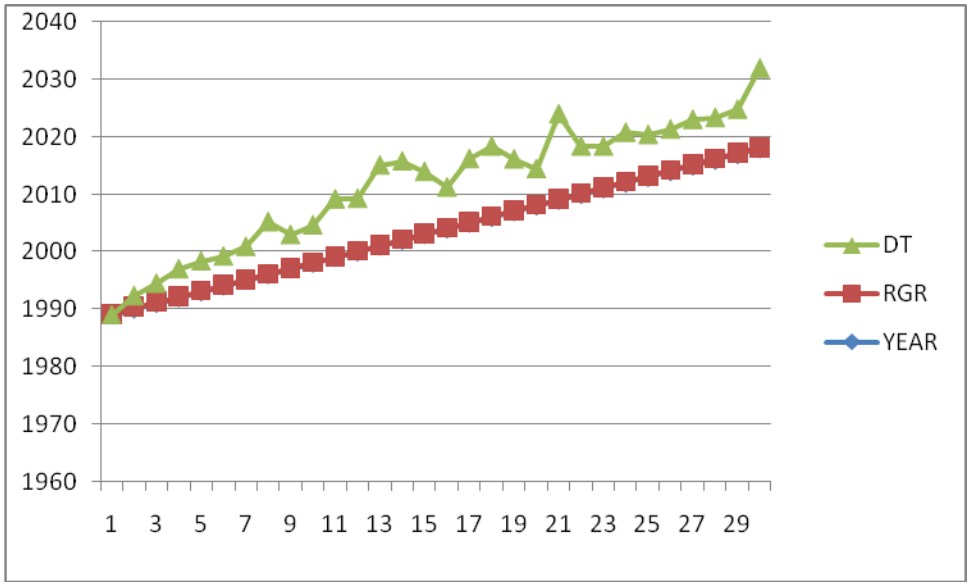

Fig.2 Relative Growth Rate (RGR) and Doubling Time (DT) of Publication

5.3 Document wise Distribution of Publications

Table. 2 & figure 3 shows that the major source of publications covered by WEB OF SCIENCE Database on research output of ICAE-IIHR in journal articles with 987 (90.14%) records, while the note with 43(3.93%) records, Editorial Material and review with 16(1.46%) record found of this study.

Document Types	Publications	%
JOURNAL ARTICLE	987	90.14%
NOTE	43	3.93%
EDITORIAL MATERIAL	16	1.46%
REVIEW	16	1.46%
NEWS ITEM	15	1.37%
MEETING ABSTRACT	10	0.91%

Table .2 Document wise Distribution of publications

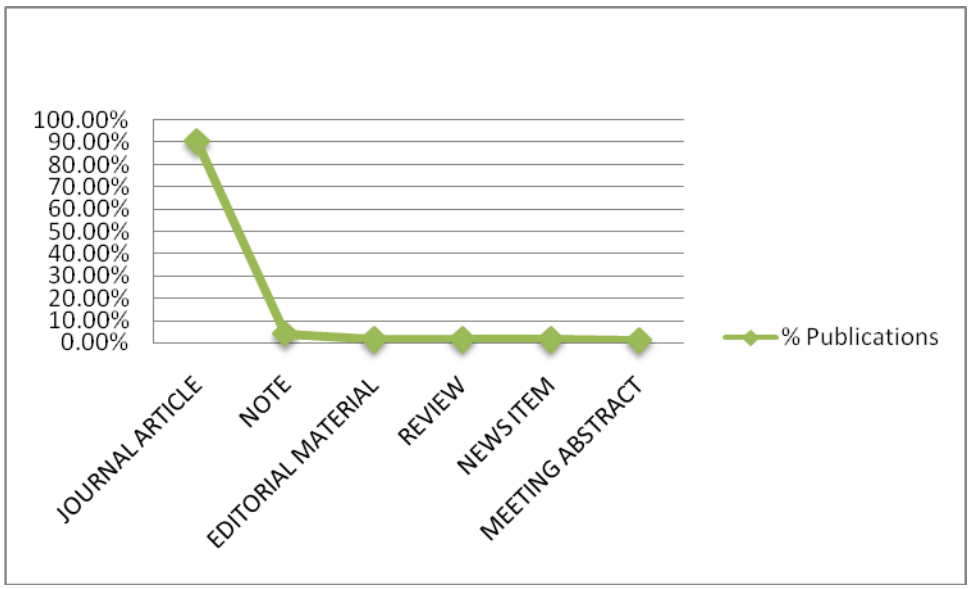

Figure.3 Document wise distribution of publications

5.4. ICAR-IIHR Research Divisions wise Productivity

Table 3 describes the research output of top divisions of ICAR-IIHR. Division of bio technology was the top in the list with 149 Papers with 13.6 % of the overall productivity of ICAR-IIHR.

ICAR –IIHR Research Division	Papers
Division of Biotechnology	149
Indian Inst Hort Res, Bangalore	128
Division of Entomology & Nematology	93
Division of Plant Physiology and Biochemistry	58
Division of Fruit Crops	49
Division of Plant Pathology	41
Pesticide Residue Laboratory	35
Division of Soil Science & Agricultural Chemistry	34
Division of Vegetable Crops	34

Tab:3 Research output of ICAR-IIHR Divisions

5.5. Most productive journals

Data was analyzed to identify the most common journals used by ICAR-IIHR faculties for publishing their research results. Totally 240 Journals were using publishing research out of that illustrates the top 15 most preferred journals by the faculties it indicates that 7 most common journals (Table 2) originated from India. There other preferred journals are from Netherlands, UK and USA. The Most Productive Journal were "INDIAN JOURNAL OF AGRICULTURAL SCIENCES"(18.3%) followed by Current Science (6.7%) and Indian Journal of Horticulture (5.3%) .By using Scientometrics Indicators such as Impact Factor (IF) and H-Type Index to find the quality of Journals, it's found the JOURNAL OF FOOD SCIENCE AND TECHNOLOGY-MYSORE had (1.797) high Impact factor followed by Scientia Horticulturae (1.76) and Current Science(0.883) .

#	Journal	Papers	Percentage	impact factor	H Type Index	Country
1	INDIAN JOURNAL OF AGRICULTURAL SCIENCES	200	18.3	0.351	21	India
2	CURRENT SCIENCE	73	6.7	0.883	98	India
3	INDIAN JOURNAL OF HORTICULTURE	58	5.3	0.229	10	India
4	JOURNAL OF FOOD SCIENCE AND TECHNOLOGY-MYSORE	36	3.3	1.797	40	India
5	SCIENTIA HORTICULTURAE	36	3.3	1.76	84	Netherlands
6	JOURNAL OF HORTICULTURAL SCIENCE & BIOTECHNOLOGY	32	2.9	0.715	50	United kingdom
7	GARTENBAUWISSENSCHAFT	20	1.8	NA	NA	NA
8	BIOCONTROL SCIENCE AND TECHNOLOGY	15	1.4	0.918	52	United kingdom
9	EUPHYTICA	14	1.3	1.546	88	Netherlands
10	FLORIDA ENTOMOLOGIST	14	1.3	1.052	45	United States
11	INDIAN JOURNAL OF BIOTECHNOLOGY	13	1.2	0.368	29	India
12	ENTOMON	12	1.1	0.07	NA	India
13	JOURNAL OF HORTICULTURAL SCIENCE	12	1.1			
14	BULLETIN OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY	11	1	1.48	61	Germany

15	INDIAN JOURNAL OF AGRONOMY	11	1	0.587	18	India

Tab:4 Most productive journals

5.6. Most prolific faculties

The top 10 prolific authors of ICAR-IIHR(Table 3) during the year 1989-2018 along with their H-index and g-index. A quantitative analysis of research output published by the faculties found the top most prolific authors were Asokan R (61), Thomas P (53), and Verghese A (44). On the contrary a quality Indicators i.e H-index and g-index has revealing that Thomas P , Asokan R and Kumar ,NKK has acquired highest citation in his single article.

Author	TP	H Index	g Index	i10 Index	Max Citation
Asokan R	61	11	16	12	29
Thomas P	53	17	23	31	42
Verghese A	44	7	10	4	20
Ravishankar KV	42	8	15	7	73
Kumar NKK	42	9	14	8	23
Mohapatra S	39	10	12	10	21
Shivashankara KS	33	9	14	8	72
Reddy MK	32	7	12	4	55
Kotur SC	31	4	6	0	7

Tab:5 Most prolific faculties (TP = Total Papers)

5.7. Authorship patterns and degree of collaboration

Table 6 gives details about the descriptive statistics for authorship pattern. It indicates that Multi authored Papers 990 (90%) reaming 105(10%) were single authored Papers its shows the degree of collaboration of ICAR-IIHR authors.

#	**Author Pattern**	**No's**
1	Single Authored Paper	105
2	Multi Authored Paper	990
3	Total Publication	1095
4	Total Authors	1593
5	Mean Per Paper Author	0.687
6	Mean Per Author Paper	1.45
7	Degree of Collaboration	0.90

Tab:6 Authorship patterns and degree of collaboration

5.8. Participating countries and Institutions collaboration with ICAR-IIHR

In table 7 and table 8, the most participating countries and institutions in collaboration with ICAR-IIHR are listed. It can be seen that United States and Horticultural experiment Station were top in these list, respectively.

#	Countries	Papers	% of 1,095
1	USA	28	2.56%
2	ENGLAND	16	1.46%
3	SOUTH KOREA	11	1.01%
4	JAPAN	8	0.73%
5	AUSTRALIA	6	0.55%
6	TAIWAN	6	0.55%
7	MALAYSIA	3	0.27%
8	THAILAND	3	0.27%
9	FINLAND	2	0.18%
10	PAKISTAN	2	0.18%

Tab:7 Collaborating Countries

#	Organizations	Papers	% of 1,095
1	CENT HORT EXPT STN	66	6.03%
2	INDIAN AGR RES INST	46	4.20%
3	KUVEMPU UNIV	37	3.38%
4	UNIV AGR SCI	36	3.29%
5	INDIAN INSTITUTE OF HORTICULTURE	32	2.92%
6	UNIV AGR SCI BANGALORE	31	2.83%
7	INDIAN COUNCIL AGR RES	24	2.19%
8	JAIN UNIV	22	2.01%

Tab:8 Collaborating Institutions

5.9. Productive research areas

The major research areas are explored using the Web of science categories which are grouped to 10 predefined major research areas such as Agriculture(43%) followed by Plant Science(16%) and Entomology (8%).

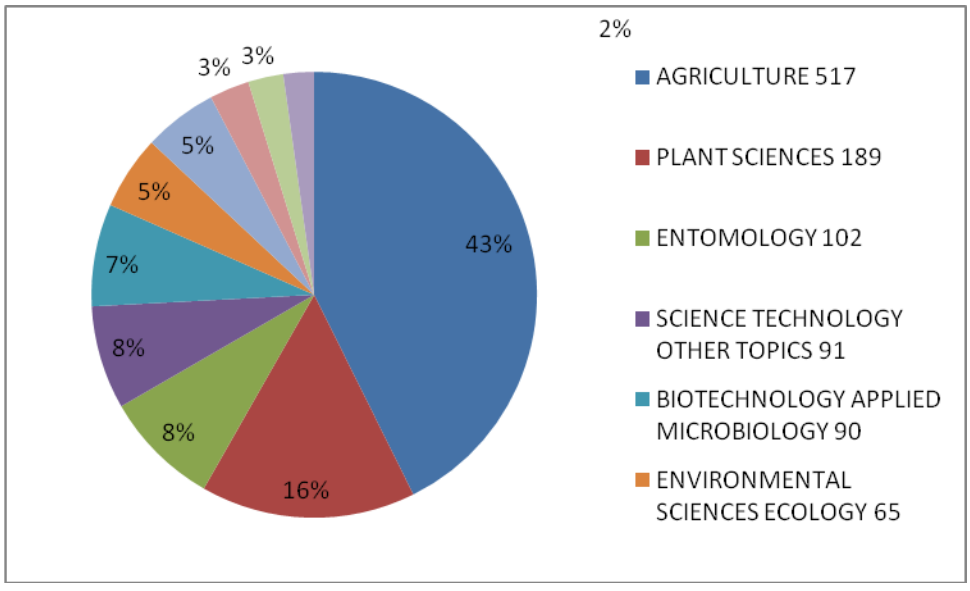

Fig.4 Major Research areas

6. Findings

- During 30 years of study period 2017 is the most productive year with 89 publications and 1999& 2011 are the least productive years with 14 publications
- It found that total citation received 1989 -2018 is 5952 and average citation per paper is 5.44, ICAR – IIHR H-index is 30 and P- Index 31.86.
- The Growth rate is 0.35 in 1989 and which decreased up to 0.05 in 2018. The mean relative Growth rate for the periods of 2010 to 2014 the relative growth rate of 0.1. This study period resulted that the mean doubling time for total output 8.12.
- Bio Technology has been identified as most productive research division in ICAR-IIHR.
- Asokan R published the highest number of articles for the study period with 61 Publications, and research output measured in terms of citation counts Thomas ,P has received More H- Index and g-index among faculties in ICAR-IIHR
- Journal articles (90.13%) have been observed as most preferred publication pattern among the faculties of ICAR-IIHR during 1989-2018.
- The most common journals used by ICAR-IIHR faculties for publishing their research results. It indicates that most common journals originated from India (35%) there other preferred journals were from the Netherlands, UK, USA and Germany.
- The faculties of ICAR -IIHR are preferred to publish their research output in most renowned journals with high Impact factor (IF) and H-index.
- Most of the ICAR-IIHR publication collaboration with in the India and ICAR-IIHR only
- ICAR-IIHR registered nine international patents and ten Indian patents in the field of Horticulture.

7. Conclusion

This study has highlighted quantitatively the research output made by the faculties in ICAR-IIHR during the years 1989-2018 as available in WEB OF SCIENCE database. During this 30 years contribution in terms of number of publications is significant and more interdisciplinary nature. Databases such as Scopus and CAB Direct Online Database would have been more appropriate source of data for the future research to reveal the research output of ICAR-IIHR.

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